at the screen or move very slowly through it, making it very probable that they will collide with the screen and give up their charge which results in a measurable electric current proportional to the concentration. The higher mobility ions move much more quickly through the screen and so have a much lower probability of colliding with and discharging on the screen. It is much more probable that the higher mobility ions will continue upstream and will give up their charge on a conductive plate at the upstream end of the detector. This also results in a measurable current proportional to the concentration of the high mobility ions.

The present apparatus and method is sensitive enough to measure low or trace concentrations of some compounds and offers advantages over currently available detection technologies under some conditions. It is capable of detecting very low concentrations of halogenated compounds in air without any prior separation. It may be used as a stand alone detector or in combination with a separation device such as, but not limited to, gas chromatography. The invention will be better understood by reference to the appended drawings and the detailed description of the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be explained and objects, other than those set forth above, will become apparent when consideration is given to the following detailed description which makes reference to the annexed drawings herein.

FIG. **1** is a schematic view of a stepped electric field detector (SEFD) as described herein configured for detecting low mobility ions;

FIG. **2** shows the SEFD configured to measure high mobility ions that have been separated from low mobility ions; and

FIG. **3** shows a dual current amplifier configuration that allows simultaneous measurement of both the low and high mobility ions.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIG. **1**, the apparatus shows one embodiment of the invention in which an apparatus and method are used to measure components of gaseous mixtures. The apparatus comprises a chamber **1** having a gas inlet **2** at one end and a gas exit **3** at the opposite end. The current embodiment of the device uses a cylindrical chamber, but chambers with cross-section geometries other than circular could be used as well.

Gas inlets **2** and exits **3** may be any type of opening or set of openings in the chamber that allows gas to flow in or out of the chamber. They may include baffles, screens or other devices to create a more uniform gas flow or control the gas flow in any manner. Gas flow through the chamber from the inlet to the exit may be provided by pumps, fans, blowers, compressors, compressed gas tanks or any other device that could generate a constant flow of gas. Gases of particular interest includes halogenated compounds, including fluorocarbons, such as Freon, and most particularly SF_6.

The chamber **1** is divided into two regions by an electrically conductive screen **4**. A grid of wires, a set of parallel wires, a porous plate or any similar divider may be used in place of the screen **4**. Requirements for this divider are that it is electrically conductive and allows gas to flow through without significantly changing the gas velocity. A conductive ring will actually work, although it may not be as efficient as other arrangements. For convenience, in the following descriptions, the divider will be referred to simply as the screen. When configured for the detection of low mobility ions as shown in FIG. **1**, the screen **4** is connected to the input of a sensitive current amplifier **7** which produces an output voltage proportional to the electric current.

The end of the chamber where the gas inlet is, or upstream end, is terminated by an electrically conductive plate, screen, grid or other device that provides an approximately planar electrically conductive surface. For convenience, this electrical conductive surface is referred to hereinafter as end plate **5**. This end plate **5** is electrically insulated from screen **4**. A voltage is applied to end plate **5** to create an electric field between end plate **5** and screen **4**. This voltage may be created with a suitable battery, power supply or other similar device. This voltage may be adjusted to maximize the separation of the lower mobility ions to be detected on screen **4** and higher mobility ions to be detected on the end plate **5**. Typically, the drift velocity of the ions to be trapped on the screen **4** should be less than or just slight greater than the gas flow velocity while the drift velocity of the high mobility ions to be discharged on the end plate **5** should be significantly greater than the gas flow velocity.

The end of the chamber where the gas exits, or downstream end, is terminated by another plate, screen or other device that provides an approximately planar electrically conducting surface. For convenience, this electrically conductive surface will be hereinafter described as end plate **6**.

Downstream end plate **6** is also electrically insulated from screen **4**. The voltage is applied to end plate **6** to create an electric field between end plate **6** and the screen **4**. This voltage may be created with suitable batteries, power supply or similar devices. The plurality and magnitude of this voltage should be adjusted such that all ions of the polarity of interest will drift toward screen **4** with a drift velocity significantly greater than the gas flow velocity. Since the electric field on the downstream side of the screen **4** is greater than the electric field on the upstream side of screen **4**, an abrupt change or step in the electric field is created at the screen **4**.

The output of the current amplifier **7** may be connected to a volt meter, chart recorder, oscilliscope, analog to digital convertor or any other voltage display or recording device.

An ionization device **8** is placed on the downstream end of the chamber. This may be a radioactive material, a corona discharge device, a photo-ionization or chemical ionization device, or any other device that will ionize the molecules of interest. The ionization may take place in the chamber or a stream of ionized molecules may be injected into the chamber near the downstream end.

Compounds to be detected may be included as part of the gas flowing through the chamber, mixed with this gas prior to its entering the chamber or introduced into the chamber separately through another port (not shown). If the flow of sample gas is small compared to the flow of primary gas flowing through the chamber, it may be introduced into the chamber at any point without disrupting the operation of the SEFD.

FIG. **2** shows the SEFD configured to measure high mobility ions that have been separated from low mobility ions. As can be seen therein, current amplifier **7** is applied to end plate **5** rather than to screen **4** as in FIG. **1**.

In FIG. **3**, current amplifiers **7** are applied both to the end plate **5**, as well as screen **4**, thereby modifying the embodiments of FIGS. **1** and **2**. The dual current amplifier configuration of FIG. **3** allows simultaneous measurement of both the low mobility and high mobility ions. This configuration requires that the current amplifier provide the proper voltage bias to the screen **4** and end plate **5** on their inputs.

A further variant of the invention shown in FIGS. **1-3** is to place multiple screens (not shown) in the SEFD. If a screen is